All vapor phase ytterbium doped silica glass fabrication by outside vapor deposition combined to chelate flash vaporization

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Abstract

The fabrication of fiber lasers requires the synthesis of high purity silica-based matrix doped with optically active ions. This glass material will then be used as core of an optical fiber with suited geometry. Yb3+-doped fibers are among the most widespread for high power applications based on large mode area (LMA) fibers because this ion possesses a simple energy level configuration and can be incorporated at high concentration levels into the silica network.
The historical way to realize such active glass is based on modified chemical vapor deposition (MCVD) and solution doping technique. Although this method allows reaching high concentration levels, some limitations remain such as radial inhomogeneity (concentration and refractive index) and small glass volume accessible. The use of vapor-phase approach based on chelates as Yb3+ ions source has partly solved this problem and has contributed to the latest advances on LMA fibers designed for high-power applications.
Nevertheless, for the fabrication of very large mode area fibers, even larger glass volumes are needed. To overcome this limitation, we have developed an all vapor-phase approach based on the outside vapor deposition (OVD) combined to chelate flash vaporization. The flame hydrolysis of chlorides and chelates precursors permits to reach relatively high Yb3+ concentration (0.6 wt.%) and to tune the optical properties of the glass by the incorporation of doping elements such as aluminum, germanium and phosphorus as well as fluorine. The resulting centimeter-sized glasses can be drawn into several meters of millimeter-sized active material used for the fabrication of micro-structured fibers. The chemical composition of these rods has been analyzed, together with the refractive index profiles and the optical properties of fibers. Low optical losses of 20 dB/km are reported at 1200 nm. Photodarkening experiments and laser efficiency measurement of fiber lasers obtained from these materials will be presented.

Keywords: outside vapor deposition, lasers, fibers and waveguides, rare earth in glass, absorption, silica, flash vaporization

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